

CLAIMS

WE CLAIM:

1. A control system for a distribution network having a set of distribution endpoints including at least one producer and consumer interconnected by a set of distribution resources including: a plurality of distribution lines joining the producers and consumers and switchable gates interconnecting the distribution lines,
5 producers, and consumers, the control system comprising:
 - a set of autonomous control units associated with at least some of the distribution endpoints;
 - a set of autonomous control units associated with at least some of the distribution resources; and
 - 10 the autonomous control units executing a stored program and communicating with each other to:
 - (a) implement a set of money rules to allocate money resources to the consumers and a set of pricing rules for distribution resources;
 - (b) bid for distribution resources on behalf of consumers based on the money
 - 15 rules and pricing rules; and
 - (c) select distribution paths between producer and consumer endpoints using distribution resources based on bid responses.
2. The control system of claim 1 wherein the distribution lines are pipes and the switchable gates are electrically operated valves.
3. The control system of claim 2 wherein the pricing rules provide higher prices to distribution between distribution endpoints requiring a greater number of distribution resources.
4. The control system of claim 3 wherein the pricing rules provide higher prices to valves that serve to segregate distributions related to separate producers.
5. The control system of claim 2 wherein the money rules provide greater money resources to a bidder if no successful bids are obtained.

6. The control system of claim 2 wherein the money rules provide initial money resources to a bidder based on the price of a previously accepted bid.

7. The control system of claim 2 wherein the autonomous control units are implemented in spatially separated hardware intercommunicating on a network and the stored program is divided among the autonomous control units.

8. The control system of claim 7 wherein the autonomous control units are located proximate to the distribution resources or distribution endpoints with which they associate.

9. The control system of claim 2 wherein the distribution network provides a distribution of a resource selected from the group consisting of: water, refrigerating liquid, air, pressurized air, and fuel.

10. The control system of claim 2 wherein the stored program executed by the autonomous control units allows distribution resources to participate in multiple bids related to different distribution consumers permitting consistent use of the distribution resource.

11. The control system of claim 2 wherein the autonomous control units associated with valves may receive an instruction causing them to close and remove themselves from future bidding;

whereby pipe failures may be isolated.

12. The control system of claim 2 wherein the consumers are assigned priorities and wherein, when all bids associated with competing consumers cannot be satisfied, the stored program executed by the autonomous control units selects among competing consumers by priority.

13. The control system of claim 2 wherein the autonomous control units associated with consumers may receive an instruction causing them to remove themselves from the system and future bidding;

whereby resources can be released for emergency conditions.

14. The control system of claim 2 further including a monitor detecting leakage from at least one point in the distribution network.

15. The control system of claim 14 wherein the network monitor monitors a volume of material flowing in the pipes to detect a leakage when this volume is above a predetermined rate.

16. The control system of claim 14 wherein the monitor comprises at least one flow rate and pressure sensors attached to a distribution line to monitor changes in flow conductances to detect a leakage.

17. The control system of claim 16 wherein the monitors collect historical information of flow conductance as a function of distribution line configurations to create a set of signatures and wherein leakage is detected when flow conductance deviates by more than a predetermined amount from the signature for the
5 distribution line configuration.

18. The control system of claim 14 wherein the monitor is implemented by a portion of the stored program running in at least one autonomous control unit.

19. The control system of claim 14 wherein the monitor is implemented redundantly by multiple portions of the program running in multiple autonomous control units.

20. The control system of claim 14 wherein the monitor controls the valves to identify and isolate a distribution resource causing the leakage.

21. The control system of claim 1 wherein the network provides redundant distribution producers.

22. The control system of claim 1 wherein the network provides redundant pipes.

23. The control system of claim 1 wherein the bidding is propagated only between distribution resources directly connected by pipes.

24. A control system for a distribution network having a set of distribution endpoints including at least one producer and consumer interconnected by a set of distribution resources including: a plurality of distribution lines joining the producers and consumers and switchable gates interconnecting the distribution lines, producers, and consumers, the control system comprising:

a set of spatially separated control modules associated with at least some of the distribution resources in proximity of the distribution resources; and

the control modules executing a stored program and communicating with each other to connect distribution resources on behalf of producers and consumers to provide distribution between producers and consumers.

25. The control system of claim 26 wherein the distribution lines are pipes and the switchable gates are electrically operated valves.

26. The control system of claim 26 wherein the network provides redundant distribution producers.

27. The control system of claim 26 wherein the network provides redundant pipes.

28. The control system of claim 26 wherein the distribution network provides a distribution of a resource selected from the group consisting of: water, refrigerating liquid, air, pressurized air, and fuel.